the numbers entered in the tables, like Table 1, under the respective columns, are collected in Table 2. This indicates the total cloudiness recorded. Then the total sums of the three several observations under the two general heads are transferred from Table 2 to the chart, where near the name of a station appears two numbers. The left-hand number is the total cloudiness recorded in the above notation for the whole sky; the right-hand is the total cloudiness for the sky near the sun. The maximum number, if complete cloudiness prevailed every day at the three observations, would be 394 for the general state of the sky, and 288 for the sky near the sun. The totals can, therefore, be readily reduced to percentages, on dividing them by this maximum number.

TABLE 2.

Stations.	Observers.	General state of the sky, a. m.				Sky near the sun, a. m.			
		8:00	8:30	9:00	Sum.	8:00	8:30	9:00	Sum
Virginia.									
Cape Henry	B. A. Blundon	71	72	67	210	35	40	40	115
Norfolk	J. J. Gray	58	55	59	172	48	40	43	131
North Carolina.									
Willeyton	H. C. Williams	57	55	50	162	42	47	40	129
Gatesville	J. T. Walton	62	61	61	184	42	43	42	127
Winton	S. S. Daniel	45	38	32	115	26	24	22	72
Tarboro	E. V. Zoeller	54	54	54	162	38	39	39	116
Weldon	T. A. Clark	46	46	45	137	27	30	28	85
Rocky Mount	Gaston Battle	37	31	30	98	25	22	19	66
Springhope	G. W. Bunn	63	62	64	189	41	41	42	124
Wilson	W. S. Harriss	37	39	41	117	22	27	28	77
Louisburg	T. B. Wilder	50	43	41	134	27	23	22	72
Auburn	Troy Poole	42	44	48	134	24	26	25	75
Selma	Dr. R. J. Noble	57	57	55	169	44	44	40	128
Raleigh	C. F. von Herrmann.	62	64	66	192	44	44	47	135
Pittsboro	A. H. Merritt	56	50	44	150	40	35	30	105
Moncure	W. H. Thompson	45	45	39	129	32	30	23	85
Fayetteville	Frank Glover	48	44	48	140	38	31	35	104
Laurinburg	L. D. McKennon	35	36	25	96	28	29	19	76
Rockingham	J. M. Stansill	41	41	40	122	29	27	29	85
Wadesboro	W. K. Boggan	27	29	29	85	18	17	19	54
Monroe	T. A. Ashcroft	61	54	53	168	42	38	38	118
South Carolina.									
Cheraw	J. H. Powe	52	52	51	155	39	38	37	114
Lancaster	J. C. Foster	68	67	66	201	45	41	39	125
Santuck	E. W. Jeter	51	48	46	145	35	33	31	99
Little Mountain.	J. M. Sease	63	59	54	176	42	36	30	108
Prosperity	J. Perry Cook	36	34	34	104	29	27	26	82
Cross Hill	E. T. McSwain	30	30	30	90	23	23	23	69
Saluda	E. L. Mathis	47	43	40	130	32	30	28	90
Greenwood	M. M. Colhoun	30	32	31	93	30	32	31	93
Trenton	C. A. Long	26[1]	29	29	84	17	17	17	51
Troy	A. C. Kennedy	69[1]	68[1]	67	204	47[1]	36[1]	35	118
Watts	J. W. Thomas	42	38	37	117	34	29	29	92
Mount Carmel	J. D. Cade	23	30	38	91	19	22	28	69
Georgia.									
Leverett	W. C. Powell	27	34	31	92	13	20	20	53
Elberton	H. A. Roebuck	15	14	13	42	12	11	10	33
Camak	J. A. Chapman	24	20	17	61	18	15	11	44
Crawfordville	J. P. Moody	45	46	42[1]	133	24	28	28	80
Athens	C. D. Cox	31[2]	30[2]	27[2]	88	17[2]	17[2]	17[2]	51
Covington	J. S. Carroll	27	28	23	78	19	22	21	62
Talbotton	W. T. Dennis	30	33	28	91	11	14	13	38
West Point	T. J. Jennings	14	12	9	35	11	8	8	27
Columbus	J. W. Long	8	11	11	30	6	10	9	25
Alabama.									
Smith Station	A. H. Frazer	22	21	20	63	17	18	17	52
Fort Mitchell	John Cantey	26	27	29	82	18	18	19	55
Auburn	James T. Anderson.	21	18	18	57	20	14	15	49
Loachapoka	W. W. David	19	21[1]	16	56	10	13	11	34
Tallassee	J. T. Jarman	26	23	21	70	20	19	18	57
Union Springs	P. L. Cowan	26	29	30	85	19	21	23	63
Matthews	W. D. Dillard	18	16	14	48	15	13	12	40
Montgomery	F. P. Chaffee	19	16	14	49	14	14	13	41
Highland Home.	S. Jordan	8	8	9	25	4	3	3	10
Fort Deposit	C. E. Rein	8	8	8	24	6	7	6	19
Greenville	F. E. Dey	11[3]	8[3]	9[3]	28	12[3]	9[3]	5[3]	26
Pineapple	J. S. Crum	19	22	20	61	19	17	16	52
Castleberry	S. Castleberry	22	22	19	63	19	19	17	55
Bay Minette	M. J. Wilkins	33	32	45	110	20	27	27	74
Latham	M. McGowan	15	15	15	45	7	7	6[1]	20
Mobile	W. M. Dudley	29	22	22	73	17	14	12	43
Mount Vernon	C. Becker	23	20	19	62	21	17	15	53
Citronelle	Dr. J. G. Michael	23	20	21	64	11	7	13	31
Louisiana.									
Poydras	P. F. Relimpio	48	46	45	139	14	13	13	40
New Orleans	R. E. Kerkam	28	41	40	109	13	21	22	56
Houma	Mrs. K. M. Haggerty.	22	20	17	59	12	11	8	31
Paincourtville	J. E. Le Blanc	33	38	43	114	24	28	34	86
Franklin	J. M. Bonney	45	49	54	148	31	33	34	98
Centerville	T. P. Boutte	21	22	22	65	14	22	25	61

[1] One day missing. [2] Two days missing. [3] Four days missing.

An inspection of Table 3, percentage of cloudiness, shows that the conditions in the *interior of Georgia and Alabama were better than in North Carolina, South Carolina, or Louisiana.*

TABLE 3.—*Percentage of cloudiness by States.*

Name of the State.	General sky.	Near the sun.
North Carolina	35.8	33.3
South Carolina	33.7	32.1
Georgia	18.4	16.0
Alabama	15.2	14.9
Louisiana	26.5	21.5

Judging from this table it would be much safer to locate in central Georgia or Alabama, upon the southern end of the Appalachian Mountains, *where the track crosses the elevated areas,* than nearer the coast line in either direction, northeastward toward the Atlantic coast, or southwestward toward the Gulf Coast.

TABLE 4.—*Average cloudiness for the several months of the year, as deduced from long series of observations* (*scale* 0–10).

Stations.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
Cape Henry, Va	5.8	4.9	5.0	5.0	4.4	4.5	4.7	5.1	4.4	4.2	4.9	5.3	4.8
Norfolk, Va	5.4	5.5	5.1	4.8	4.8	4.8	4.8	5.1	4.7	4.2	4.7	4.8	4.9
Raleigh, N. C	5.6	6.5	5.4	4.7	4.8	5.1	5.6	5.7	5.2	4.3	4.6	4.7	5.2
Charlotte, N. C	5.7	5.3	5.0	4.6	4.8	5.1	5.2	5.2	4.8	3.9	4.3	4.8	4.9
Atlanta, Ga	5.7	5.5	4.7	4.4	4.5	5.1	5.2	5.4	4.4	3.8	4.5	5.1	4.9
Chattanooga, Tenn	6.1	6.0	5.2	4.8	4.7	4.9	4.9	5.0	4.5	4.1	4.8	5.7	5.1
Montgomery, Ala.	6.0	5.9	4.8	4.6	4.4	5.2	5.3	5.0	4.4	3.8	4.6	5.4	5.0
Mobile, Ala	5.5	5.4	4.9	4.8	4.4	5.1	5.3	5.0	4.5	3.7	4.4	5.2	4.8
Meridian, Miss	5.1	6.1	5.1	5.1	4.9	5.5	6.3	5.6	4.2	2.5	4.3	5.1	5.0
New Orleans, La	5.3	5.2	4.8	4.8	4.3	4.7	4.9	4.7	4.3	3.5	4.5	5.2	4.7

To exhibit the average cloudiness for these districts, as compiled from data extending over many years, Table 4 is added. It indicates that there is a minimum of cloudiness for May in the South Atlantic and Gulf States, and therefore this season of the year is generally favorable for eclipse work.

An examination of the several days of the interval, May 15 to June 15, 1897, shows that days of cloudiness occurred from May 29 to June 9, the remaining days being generally clear. An inspection of the daily weather maps for the same period shows that from May 15 to May 29, areas of high pressure persistently covered the South Atlantic States, giving fine, clear weather; from May 30 to June 15, the high areas were located in the northwestern districts of the United States, that is, in the Missouri Valley, causing low pressures and lowering skies in the Southern States. Rain areas tended to prevail in the Mississippi Valley, and also on the North Atlantic coast, in which districts the conditions would have been much less favorable for seeing the eclipse than in Georgia and Alabama. It is intended to repeat these observations during the years 1898 and 1899, after which we shall be as well informed as possible regarding the selection of the eclipse stations for the year 1900.

FORESTS AND RAINFALL.[1]

By Prof. H. A. HAZEN (dated September 15, 1897).

Can it be possible that the cutting away of forests affects the amount of precipitation in any locality? To many, no doubt this question will seem easy of answer, but we find the results of study by no means reassuring, and recent investigations have led to almost diametrically opposite conclusions, depending, somewhat at least, upon the feeling of the writer. When we reflect that our rain storms are of very wide extent, oftentimes over 1,000 miles in diameter, and may take their origin and bring their moisture from distances of 1,000 miles or more, the thought that man, by his puny efforts, may change their action, or modify it in any manner, seems ridiculous in the extreme.

It has been well established that forests have a most im-

[1] Presented at the annual meeting of the American Forestry Association at Nashville, Tenn., September 22, 1897.

portant bearing upon the conservation of rainfall; that the forest floor permits a seepage of water to the source of springs and thus maintains their steady flow; that they hold back the precipitation that falls, especially in the form of snow, thus preventing or ameliorating the effects of dangerous freshets. There is not the slightest doubt of their great importance to the welfare of man, but all these facts do not affect the question of their influence upon precipitation. The following paper is prepared from the standpoint of a meteorologist, and is an attempt to present facts.

Formerly, the historical argument was a favorite one, I quote one of these: "It is a familiar fact that there are many regions in Asia and southern Europe, once exceedingly fertile and densely populated, that are now utterly sterile and desolate. The country bordering on the Euphrates and portions of Turkey, Greece, Egypt, Italy, and Spain are now incapable of cultivation from lack of rain due to deforestation." The most fertile of all provinces in Bucharia was that of Sogd. Said Malte Brun in 1826, "For eight days we may travel and not be out of one delicious garden." In 1876 another writer says of this same region: "Within thirty years this was one of the most fertile spots of central Asia, a country which, when well wooded and watered, was a terrestrial paradise. But within the last twenty-five years a mania of clearing has seized upon the people, and all the great forests have been cut away and the little that remained was ravaged by fire during a civil war. The consequences followed quickly and this country has been transformed into a kind of arid desert. The water courses are dried up and the irrigating canals are empty." It has also been said that in the older settled portions of New England and the Middle States there are arid hills and worn-out fields, due to the falling off of precipitation from the cutting away of the forest growth. Such quotations and statements might be made to fill a large volume. Without more precise data as to rainfall it would be hazardous to conclude that we have here a case of cause and effect. It is certain that the fertility of these regions in ancient times was due to stupendous irrigating devices and canals, and when these were neglected, through wars and other untoward circumstances, the fertility necessarily ceased. It is certain that there are ruins of enormous irrigating ditches and canals in Babylonia, where history indicates that there was once a teeming population and great fertility, but where now only a sandy desert greets the eye.

Some have said that where our densest forests are found there we have the greatest precipitation. There is no way whereby we can see that such forests would have started unless favored by rainfall, so that the presence of the forest rather indicated the earlier occurrence of practically the same rainfall as at present. Meteorologists are agreed that there has been practically no change in the climate of the world since the earliest mention of such climates. Plants found in mummy cases in Egypt that were plucked thousands of years ago show the same size as those now found in that land. The "early and the latter rains" are experienced in Palestine to-day just as they were four thousand years ago. Jordan "overflows all its banks" to-day, in February, precisely as it did in Joshua's day. When we come down to recent times and to the records of rainfall measured in New England for more than one hundred years or, at least, before and since the forests were cut, we find a constancy in the rainfall which shows its entire independence of man's efforts. Right here it should be noted that totally barren lands of any extent, in New England for example, are to be found only in imagination. Even where the forest has been cut away mercilessly there springs up a growth of sprouts which covers the ground and answers almost the same purpose in causing rainfall (if there is any effect of that kind) as the forest. Even where land is entirely cleared of a forest we have at times the green pasture, and at others still heavier crops which leave the ground anything but a sandy waste.

But the strongest argument adduced in the past to show the influence of forest on rainfall has existed in a comparison between rain-gauge measures in the forest and the open field. Such records have been made for more than thirty years in France and Germany and surely we must have here, if anywhere, a sufficient proof of a forest's influence.

Admitting that we have perfect instruments and careful observers, there still remains a most serious doubt as to the immediate environment of each gauge and as to the possibility of a direct comparison. It is probable that no two gauges 2,000 feet apart can be placed so as to catch the same amount of rain, though to all appearances the exposure is faultless in each case. This is plainly seen on the roof of a building. For example, before the office of the Weather Bureau was removed to its present location in Washington, eighteen rain gauges were placed on the roof and one upon the sod not 500 feet away. There was only one of the gauges that gave the same rainfall in all storms as the one on the sod. Some of the others gave more in some storms and some less, but all of them in the total rainfall of eight months gave less than the one which compared exactly with the sod gauge. In an early publication of rainfall records in this country (not by the Weather Bureau, however,) two stations are given, Marengo and Riley, in Illinois, not more than 3 miles apart, but yet differing by 19 inches in the total annual precipitation for several years. I have no doubt that in the latter instance one or both gauges were badly exposed; but enough has been said to show the extreme caution needed in studying such records and the absolute necessity that exists in obtaining a comparison between gauges that are not affected harmfully by their surroundings.

One of the best of all researches in this line has been conducted at Nancy, in France. Within a distance of 5 or 6 miles there have been four stations established. At Nancy in the open and at Belle-Fontaine in the forest; and, 500 feet higher vertically, Amance (open) and Cinq-Tranchées (forest). The latter stations are in a more hilly region and can not be compared together, as can the former. At the lower stations we have comparative observations for twenty-five years. I have summed these in three groups, containing eight, eight, and nine years in each group. First group, Nancy (open), had 31.16 inches, while Belle-Fontaine (forest) had 32.46 inches; second group, 33.39 inches and 34.07 inches; third group, 30.05 inches and 29.89 inches. We see that while the first eight years showed a very slight excess in the forest rainfall over that in the open field, in the last nine years (including 1894, last published) the open station showed a little more rain than the forest station. These observations were made with particular care, for the purpose of exactly determining the influence, and may be relied on if the environments of the gauges were comparable. At Amance (open) and Cinq-Tranchées (forest) the observations have not been quite so regular, though we have twenty-five full years of records at these two stations, but not the same years as at the other stations. Amance shows 26.70 inches and Cinq-Tranchées (forest) 33.39 inches, or an apparent preponderance of 6.7 inches a year in the forest. This would make more than 20 per cent greater in the forest than in the open. It should be borne in mind, however, that these last two stations are on an eminence, and are not strictly comparable, and this result can not vitiate that at the two other stations, which shows no effect.

In Germany we have a rather remarkable record of a slightly different character. Lintzel is a station on the Luneburg heath, which began to be planted with trees in 1887, at the rate of 1,000 to 1,500 acres a year, and in a few years over 8,000 acres were covered. In the midst of this forest is the meteorologic station in an open field of some 75 acres. Before planting the forest 97 per cent of the surface was field, meadow, or heath, and afterward 80 per cent was forest and 20 per cent was roads, open field, and heath. Around this station, pretty evenly distributed, and within 50 miles, there are thirteen rainfall stations, which have been carefully established and presumably are comparable with the Lintzel station in the midst of the growing forest. There is no means of knowing whether any of these stations have been changed or not, but for our purpose we may consider the material homogenous and treat it accordingly. Records from 1882 to 1896 (fifteen years) are available. Charts were prepared for each year showing the ratio between the Lintzel record and that at each station of the thirteen. There is no space for these charts, but, in place of them, I give here the mean of all the thirteen station ratios for each year: 1882, 81; 1883, 83; 1884, 101; 1885, 103; 1886, 82; 1887, 98; 1888, 93; 1889, 122; 1890, 97; 1891, 100; 1892, 90; 1893, 96; 1894, 142; 1895, 128; 1896, 136.

These figures are extremely significant, and may be further elucidated as follows: The smaller ratios show a less rainfall at Lintzel, or, these figures are the percentage of rainfall at Lintzel as compared with surrounding stations. It is impossible to determine whether these trees have reached the culmination of their effect or not. In 1896 most of them would be seventeen years old, and the ground would probably be fairly covered. It is a great pity that the environment was changed or some accident happened at Lintzel so as to vitiate the three last years. (An inquiry was sent to Germany regarding the error, but no response has yet been received.) The record does not seem to show any appreciable effect upon the precipitation; in 1884 the ratio was 101, while in 1893, nine years later, it was 96. It is probable that no definite and unassailable result can ever be obtained either by the method adopted in France or this later one in Germany. The rainfall is so variable within a distance of even a mile or two, and it is so difficult, if not impossible, to obtain similar environments at all the stations, that no decisive result can be obtained. It will be seen readily that the multiplication of stations will do no good, and, above all, that the observation of rainfall under trees in a forest is absolutely useless for any such discussion or study as this.

It seems probable that if two or three lines of stations could be established a mile or two apart on four sides of an enormous forest, each line to have a dozen stations or so, about 3,000 feet apart, four of the stations to be outside of the forest and the others each in a large, cleared space of at least 2 acres extent in the forest, something decisive might be obtained. It should be noted, however, that from the evidence already accumulated there would be very little to be gained by a further study of the question. It is certain that the effect, if there be one, is almost inappreciable. The favoring conditions over the forest are balanced by those not favoring and the integrated effect is practically the same in the two cases.

Prof. H. F. Blanford, of India, determined from a most careful series of records, from which all known errors had been eliminated, that the forest had a tendency to give 2 per cent more rain than contiguous open fields, That is, if an open place had 50 inches of rain in a year a near by forest would have only 51 inches, which is practically inappreciable.

It would be an interesting study to select all those cases in experiments in forest and near by fields in which the wind was blowing either from the forest to the field, or *vice versa*. It is evident that if there is any effect on rainfall by the forest, it would be vitiated if not exactly reversed by such winds.

There is a class of visual observations which seem to show an effect upon rainfall by the forest. Probably many have seen heavy clouds passing over a plain, but which only precipitated as they passed over a forest. Also in a hilly region it is a frequent phenomenon that fog and low lying cloud hover near a forest, and not over an open plain. One also notes very often in passing into a forest on a damp day that the trees drip moisture, possibly condensed from moisture evaporated from the damp earth underneath. Observations of this nature, however, can not ordinarily be checked by instrumental means, but show in a general way that the forest tends to conserve vapor and moisture which in the case of the open field would be diffused into the atmosphere.

REPORT ON THE OPERATION OF THE MOUNT TAMALPAIS STATION FOR SEPTEMBER, 1897.

By W. H. HAMMON, Forecast Official.

The station is on a comparatively narrow neck of land (about 8 miles wide) between the ocean and the Bay of San Francisco, and across the Golden Gate (entrance to San Francisco harbor) from San Francisco and about 13 miles distant therefrom. It is on a very abrupt peak, 2,592 feet high, at the eastern end of a short range of mountains running east and west across the peninsula. From the peak the surface declines very abruptly almost to sea level on the north, east, and south faces.

It is an ideal place for an observatory, in that nothing obscures the outlook and because the point is above all disturbing influences of local conditions and topography. At San Francisco wind directions and velocities are greatly influenced by the surrounding hills. Moreover, the intense heat of summer in the interior valleys of the State causes a most remarkable indraft from the sea on summer afternoons and nights, which more than half the time in such seasons is laden with fog, and the latter either surrounds the observer or obscures the sky at the hours of observation. On fourteen out of the twenty-three p. m. observations which have been repeated to me from the city a westerly wind exceeding 20 miles per hour has been reported. On but four of these occasions has the wind at this station reached that velocity, and three of these were during a severe northwest gale, which occasioned a most unusual cold wave in the Pacific Coast Region. More than half the time at the hours of observation the valleys and sea below have been obscured by fog, but only on three occasions has the fog enveloped the peak. While the sky has been reported obscured at fifteen of the observations repeated from San Francisco, on only five occasions has that been the case here.

It is believed that the conditions observed here are of especial value to the forecaster. Rain has been recorded at some of the stations in northern California on fifteen weather maps. On fourteen of these occasions it has been preceded from twelve to forty-eight hours on the mountain by high winds and gales, amounting to 350 miles or more per day, the force of the wind being in a measure proportional to the extent and severity of the storm. The one exception was a trace of rain at San Francisco, which was merely a mist precipitated from a low cloud or fog entirely below the summit of the mountain. With one exception there has been no instance when the wind has reached a movement of 400 miles per day that rain has not followed within thirty-six hours. The exception was when a gale on the 13th continued on the 14th and rain occurred on the night of the 13th and 14th.

Another indication of rain which is especially observable here is the unusual visibility of the air.

From this peak cumulo-stratus and cumulo-nimbus clouds, which precede and accompany local showers in the valley, can be seen and their courses followed for 100 miles or more at times when the smoke and dust of lower elevations would obscure them at much shorter distances. The dust and smoke of forest fires usually ends quite abruptly at about 1,500 or 2,000 feet elevation.